LANDMANN.

THE PRINCIPLES OF
ARTILLERY       1801

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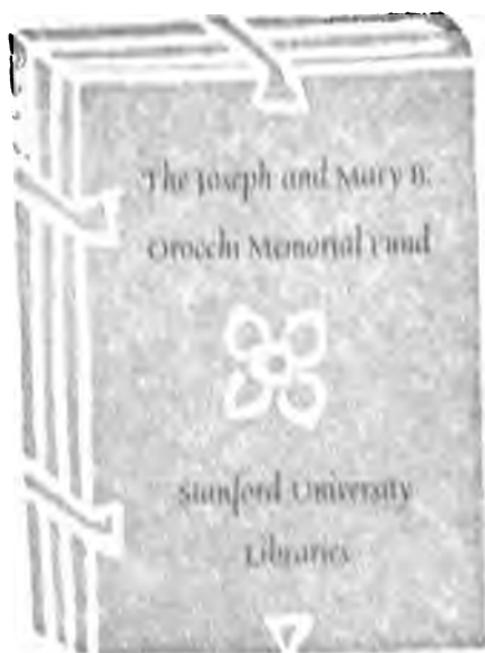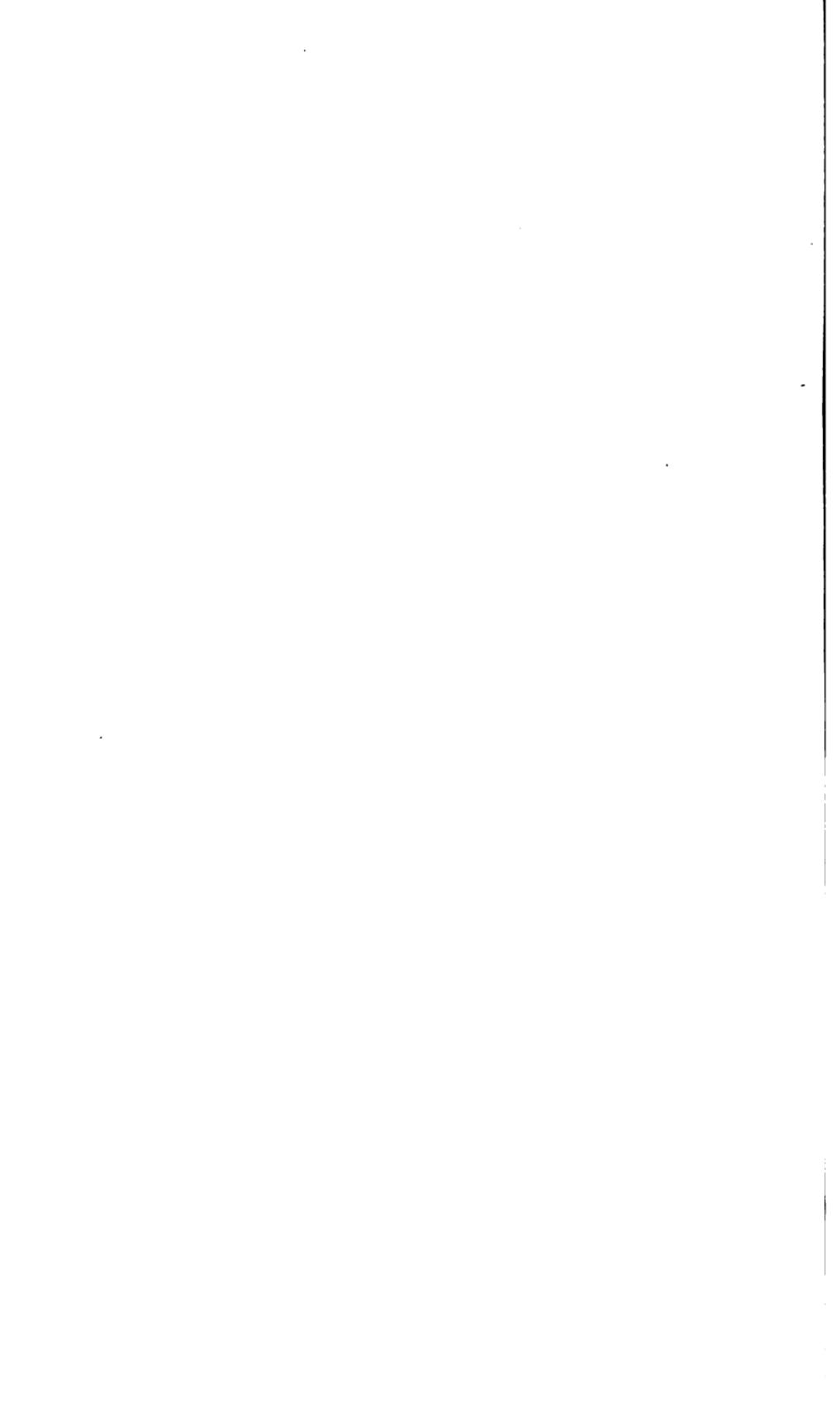
# QUESTIONS AND ANSWERS

## UPON

# ARTILLERY.

# THE

## PRINCIPLES

OF
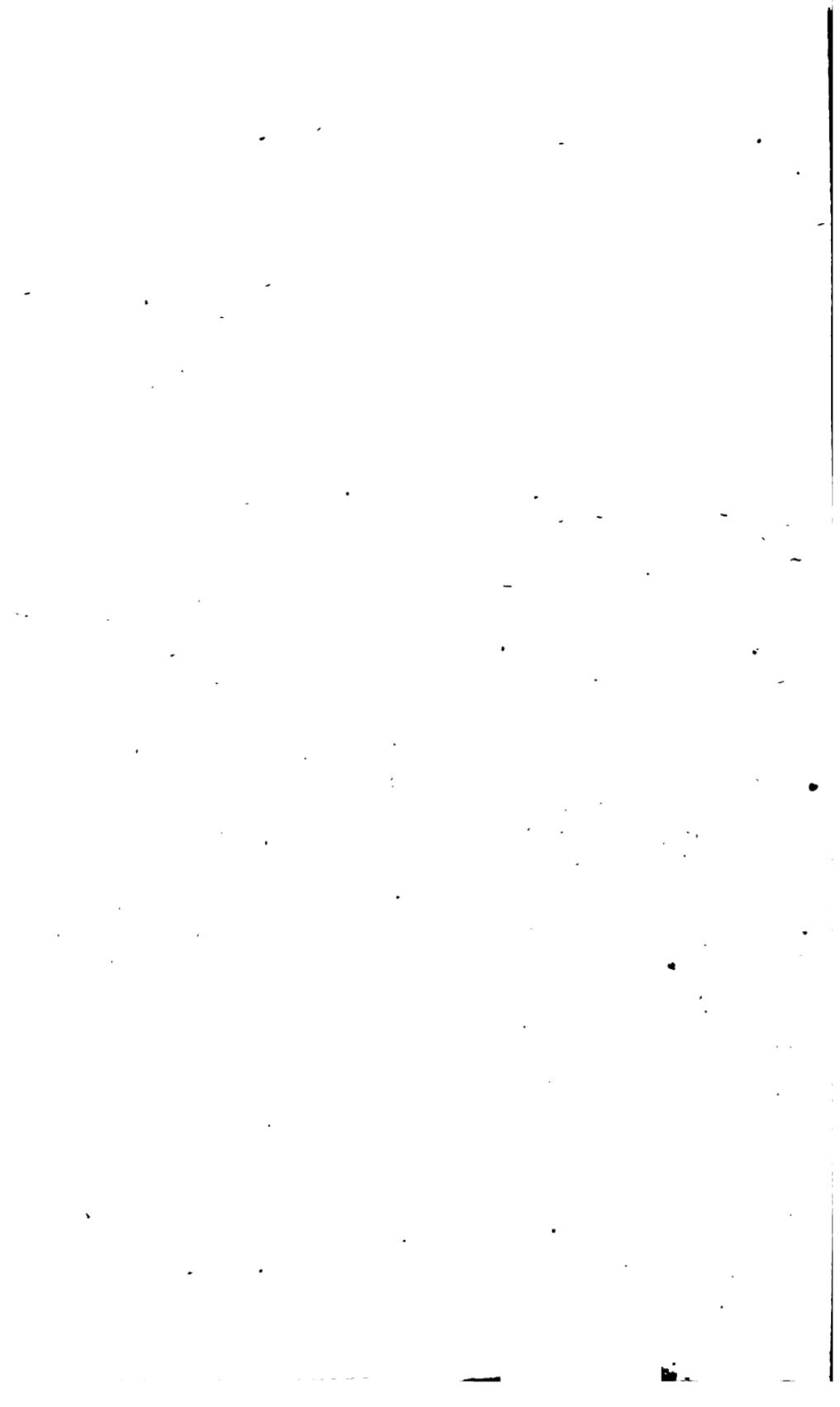
# ARTILLERY,

REDUCED INTO

# QUESTIONS AND ANSWERS,

FOR THE USE OF

*THE ROYAL MILITARY ACADEMY,*

AT

## WOOLWICH.

BY

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*Professor of Fortification and Artillery.*

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# QUESTIONS AND ANSWERS

UPON

## ARTILLERY.

1. *WHAT are the component parts of gunpowder?*

Nitre, charcoal and sulphur.

2. *In what proportion are these ingredients mixed?*

The proportions in different countries are not exactly the same. In England 75 parts of nitre to 15 of charcoal and 10 of sulphur are commonly used, and

B

in France the composition is not materially different.

**3. On what does the strength of gunpowder principally depend?**

In the purity of the ingredients, and on their intimate mixture.

**4. What is nitre and of what does it consist?**

It is a neutral salt, composed of the nitrous acid and the fixed vegetable alkali. It is soluble in 5 or 6 times its weight of cold, and in about half its own weight of boiling water.

**5. How is nitre distinguished from other neutral salts?**

By the figure of its crystals, which are six sided prisms, and its property of deflagrating or detonating with inflammable substances, when raised to a red heat.                  6. *What*

6. *What are the impurities commonly found in nitre and how are they detected?*

Nitre may be contaminated with a variety of different salts; but those most commonly met with, are, *nitrated lime, nitrated magnesia, muriated magnesia, common salt,* and *salt of Sylvius*; the latter of which is the most frequent, and the most difficult to separate. The earthy salts, are readily detected by fixed vegetable alkali, or mineral alkali, and the common salt, or salt of sylvius, by nitrated silver.

7. *How is nitre purified?*

By crystallization. Nitre being much more soluble in hot than cold water, it crystallizes by cooling, whereas common salt being equally soluble in hot

and

and cold water, is separated by evapo-
ration only, and the liquor being filter-
ed while hot, all the common salt not
dissolved will consequently remain on
the filtre. The earthy salts do not
crystallize, and are therefore easily se-
parated. This process should be re-
peated two or three times or oftener,
until the nitre is found to stand the
test of the solution of silver; or at
least until the transparency of the liquor
is but little affected.

8. *What is sulphur and how is it dis-*
*tinguished from other substances?*

It is a brittle lemon-coloured sub-
stance, which emits a peculiar smell,
when heated. It melts at a degree of
heat somewhat higher than that of
boiling water; it burns with a lambent
blue flame, before it becomes red hot,
<div align="right">and</div>

and forms vitriolic acid ; in close vessels it sublimes in a lemon-coloured powder called flowers of sulphur.

9. *How are the impurities of sulphur detected ?*

Sulphur may contain arsenic, calcarious earth, pyrites, and several other substances. All these may be detected, by sublimation, for, the sulphur will rise in flowers and leave the impurities behind. Arsenic however will rise along with the sulphur. but its presence may be known from the colour of the flowers, which in this case will be tinged more or less of a red or orange colour.

10. *How is sulphur purified ?*

The purest sulphur is that obtained by sublimation; but sulphur tolerably

pure

pure may be procured, by keeping it in fusion for some time, when the greater part of the impurities will subside to the bottom or float on the surface, the latter being taken off, and the sulphur poured into moulds, the middle part of the lump thus obtained, will be found to contain sulphur of a considerable degree of purity.

11. *What is the best charcoal for making gunpowder?*

That obtained by distillation in an iron cylinder, is allowed to be far superior to any other; and it does not appear to be of much consequence from what wood it is made.

12. *In what manner is gunpowder manufactured?*

The different ingredients (properly purified)

purified) in the proportion of 75 parts of nitre, to 15 of charcoal and 10 of sulphur, are reduced to powders, and mixed, they are then moistened with water, and worked in a mill for 5 or 6 hours or longer, until the mixture-is found to be as intimate as possible ; for upon this circumstance the strength of the powder in a great measure depends.

13. *How is the Composition reduced into grains?*

When taken from the mill it is put into a press and formed into hard lumps of a considerable size; these when dry or nearly so, are broken by wooden mallets into small pieces; they are afterwards put into sieves, and forced by means of a wooden roller through circular holes of a proper diameter.

14. *How is gunpowder proved?*

By

By inflaming a small quantity of it
on white paper, if it is good it will
instantly take fire; the smoke will rise
in form of a column, leaving no black
spots on the paper nor any particle that
will burn it.

15. *How is the strength of gunpowder
   particularly ascertained?*

By firing some rounds from an 8 inch
mortar laid at 45 degrees and loaded
with a particular powder, which has
been made with the greatest exactness,
called *proof-powder*; the same number
of rounds are then to be fired, from the
same mortar charged with an equal
quantity of the powder to be proved;
and by comparing the ranges the
strength of the powder will be ascer-
tained.

16. *What is the date of the Invention
   of gunpowder?*

It

It is usually ascribed to Bartholdus Schwartz, a German monk; who is said to have discovered it about the year 1330.

17. *How are the principal pieces of ordnance distinguished?*

Into great guns or cannon, mortars and howitzers.

18. *Of what metals are these several pieces composed?*

They are made of iron or gun-metal commonly called brass.

19. *What is the species of iron most proper for guns and mortars?*

The pig-metal or cast-iron, which possesses the greatest strength, and which is consequently most proper for casting guns and mortars, is that which

C                              is

is neither perfectly white, nor perfectly grey, but which is in an intermediate state between them.

20. *How is the gun-metal composed which is used for brass guns, mortars and howitzers?*

Copper and tin are melted together, in the proportion of 8 or 12 pounds of tin to 100 pounds of copper; this constitutes gun-metal. The largest proportion of tin is used for mortars, where a greater degree of hardness is necessary.

21. *Why is tin used in gun-metal?*

It renders the composition hard, and by promoting the fusion of the copper communicates solidity to the mixture when cast into ordnance.

22. *What is the use of copper in gun-metal?*

It

It gives, with a due proportion of tin, strength and malleability to the composition. Copper alone is of too soft and flexible a nature for guns, and if too great a proportion of tin is used, it destroys the malleability.

23. *What is the usual shape of a cannon?*

Its general form is the frustum of a right cone, from which a cylinder described about its axis is taken away; the exterior part is ornamented with mouldings, and the thickness of metal in the whole length is different, in order to give to those several parts their proper solidity, where a greater resistance is required against the effects of the gunpowder.

24. *Why is the thickness of metal*

C 2 *made*

*made less towards the mouth of a cannon ?*

The elastic force of inflamed gun-powder being in the inverse ratio of the capacity in which it is contained; its efforts against the sides of the piece, will be much diminished when the shot has reached the mouth.

25. *What are the principal parts of a gun ?*

The first reinforce, the second rein-force, the chace, the breech, the cas-cable, the muzzle, the trunnions, the dolphins, the bore and the vent.

26. *How are the different natures of guns distinguished ?*

By the weight of their shot, from which they take their name; thus a cannon which throws a shot of 42 pounds,

pounds, is called a 42 pounder, a 24 pounder is a cannon which projects a shot of 24 pounds, and so on.

27. *How are the several natures of mortars and howitzers distinguished?*

By the diameter of the bore as for example, a 13 inch mortar, is that whose diameter of the bore is 13 inches, and the howitzer, whose bore is 10 inches, is called a 10 inch howitzer, and so on.

28. *What advantages have brass guns over iron, and iron over brass?*

Brass guns are not so liable to burst, when constructed upon a light principle, and are therefore better adapted for field service, in which they are subject to be violently heated by quick firing; but good iron guns are preferable

ble to brass in every other respect, and particularly those of large calibres, and of a heavy construction.

29. *What are the different natures of brass guns ?*

42, 24, 18, 12, 9, 6, 3 and 1 pounders heavy;

24, 12 and 6 pounders medium;

and 24, 18, 12, 9, 6, 3 and 1 pounders light.

30. *What are the different natures of iron guns ?*

32, 24, 18, 12, 9, 6, 4, 3 and 1 pounders.

31. *What is a carronade ?*

It is a short piece of iron ordnance used as a cannon; it has instead of trunnions, a loop at the lower surface of the reinforce by which it is fixed to

its

its carriage. The carronade takes its name from being first cast at Carron.

32. *What are the several natures of carronades ?*

68, 42, 32, 24, 18 and 12 pounders.

33. *What is the length and weight of a 42 pounder brass gun ?*

It is 9 feet 6 inches long and weighs 61 cwt.

34. *What is the length and weight of a 32 pounder, iron gun ?*

It is 9 feet 6 inches long and weighs 55 cwt. and 2 qrs.

35. *What is the length and weight of a light brass 24 pounder ?*

It is 13 calibres in length and weighs 24 cwt.

36.

36. *What is the weight of a brass* 12 *pounder field piece, whose length is* 17 *calibres?*

It weighs 18 cwt.

37. *What is the weight of a brass* 12 *pounder of* 17 *calibres mounted on its carriage, the timber included?*

42 cwt.

38. *What is the weight of a* 24 *pounder garrison standing carriage?*

14. cwt.

39. *How many different natures of mortars are made use of?*

For sea service two, the 13 and 10 inch mortar, of brass and iron. For land service, five, the 13, 10, 8, $5\frac{1}{2}$ and $4\frac{2}{5}$ brass, of which the 13, 10 and 8 inch, are also made of iron; the $5\frac{1}{2}$

inch

inch is likewise called a royal mortar and the 4⅔ a coehorn mortar.

40. *What is a stone mortar ?*

It is a mortar whose bore is 15 inches more or less, having a chamber to contain about 2 or 3 pounds of powder, it is made of brass and of a much lighter construction, than other mortars. Its use is to throw stones to the distance of from 150 to 200 yards.

41. *What are the principal parts of a mortar ?*

The breech, the reinforce, the chace, the trunnions, the bore, the chamber, the vent and the dolphins.

42. *What is the weight of a 13 inch sea service or garrison iron mortar?*

28 cwt.

D          43. *What*

43. *What is the weight of a 13 inch land service brass mortar?*

25 cwt.

44. *What is the weight of a 13 inch land service iron mortar?*

38 cwt. 2 quarters.

45. *What is the weight of a 13 inch sea service mortar bed of wood?*

38 hundred wt. 3 quarters and 13 pounds.

46. *What is the weight of a 13 inch garrison iron mortar bed?*

95 hundred wt.

47. *What is the weight of a 13 inch land service iron mortar bed?*

50 hundred wt.

48. *What is the weight of a 13 inch land mortar bed of wood?*

21 hund-

21 hundred wt. 2 quarters and 7 pounds.

49. *What are the several natures of howitzers?*

10, 8, 5½ and 4⅖ inch.

50. *What are the principal parts of a howitzer?*

The breech, the reinforce, the chace, the trunnions, the bore, the chamber, the vent and the dolphins.

51. *How are howitzers distinguished from mortars?*

By the situations of their trunnions, which in howitzers are placed at the reinforce, and in mortars at the extremity of the breech.

52. *What is the weight of a 10 inch brass howitzer?*

25 hundred wt. 3 quarters and 14 pounds.

53. *What is a petard?*

It is a small mortar made of iron in the form of a bell; its greatest diameter and axis are each 10 inches, having a fuze hole as that of a shell instead of a vent. Its use is to force open the gates of a fortress.

54. *What is the date of invention of cannon?*

They are supposed to have been first used in 1338, within a few years after the invention of gunpowder.

55. *When were mortars first employed?*

By the Turks, as is supposed at the siege of Rhodes, in the year 1523: about 200 years after the invention of cannon.

56. *What is the date of the invention of howitzers?*

They were invented by the Germans about the year 1690.

57. *What natures of guns, are used in the attack of fortified places?*

Heavy 24 and 18 pounders of brass, which are called battering pieces.

58. *What natures of guns are denominated field pieces?*

24, 18, 12, 9, 6, 3 and 1 pounders.

59. *The length of a gun being given in calibres how is the same ascertained in feet and inches?*

The product of the number of calibres by the diameter in inches of the bore or calibre is divided by 12 and the quotient will be the length in feet and inches.

50. *By what names are different gun
carriages distinguished ?*

They are called travelling and stand-
ing carriages; the travelling carriages
are those upon which guns are mounted
for the operations in the field, and the
standing carriages are for sea and gar-
rison service.

61. *How many sorts of wood are made
use of in the construction of gun
carriages and mortar beds ?*

Three kinds, oak, elm and ash.

62. *Of what sort of wood is the sea
mortar bed and house composed ?*

The bed and house are made of oak
and bed bolster of elm.

63. *What sort of wood is employed
for land mortar beds ?*

The bottom part is made of oak and
the upper part of elm.

**04.** *What sort of wood is used for ship and garrison carriages ?*

The garrison carriages are made of oak, and their trucks of iron; but in ship carriages the cheeks or sides, transoms and trucks are made of elm, and the axletrees of oak.

**65.** *What sort of wood is used for the 12 and 24 pounder travelling carriages ?*

In the heavy 12 and 24 pounder travelling carriages, the cheeks and transoms are of elm, and the axletree of ash; in the wheels the nave and felliés, are of elm and the spokes of oak; in the limber the shafts, bars and axletree are of ash.

**66.** *What sorts of wood are used for the several pieces of light travelling carriages ?*

From the 3 to the 12 pounder, the cheeks and transoms are of elm, the axletree of ash, and the ammunition boxes of fir; in the wheels the nave is of elm, the spokes are of oak and the fellies of ash; in the limber the shafts, bars and axletree are of ash.

67. *Why is elm used for the naves of wheels in general?*

Because it is of a tough quality and the nave being pierced with large holes, for the spokes to be driven hard into; that wood is used as not being liable to split.

68. *Why is oak used for the spokes of wheels?*

On account of its strength and duration, and because it is the smallest scantling in the wheel.

69. *Why is ash used for the fellies of light wheels?*

Because being cut circular, they are thereby weakened at each end, wherefore ash is chosen as being a tough wood; for the same reason it is employed for the shafts of the limber.

70. *Why is elm used for the fellies of heavy wheels?*

Because the scantling is large, and the strakes broad and double nailed; elm is therefore preferable to ash, on account of its lightness, and it is less expensive.

71. *Why are garrison carriages made of oak?*

Because they are more exposed to the weather than ship carriages; which are made of elm on account of its being cheaper and lighter than oak.

E              72. *What*

72. *What diameter is given to the vent in guns, mortars, and howitzers?*

Two tenths of an inch.

73. *What is termed the windage?*

It is the difference between the diameter of the bore, and, the diameter of the shot or shell.

74. *What proportion of windage is allowed in guns?*

One twentieth of the diameter of the ball.

75. *What windage is allowed in mortars and howitzers?*

From the 13 to the $5\frac{1}{2}$ inch, the windage is ·75 of an inch, and that of a $4\frac{2}{5}$ inch ·2 of an inch.

76. *In what state is a gun said to be honey combed?*

When

When the surface of the bore is full of little cavities or holes.

77. *What is meant by the scaling of a gun?*

It is the cleaning the inside of a piece, by firing out of it a small quantity of powder, in order to blow out any dirt or scales of rust, which may adhere to the interior surface.

78. *What is the charge of powder for scaling guns?*

$\frac{1}{14}$ of the shot's weight.

79. *What quantity of powder is used for proving iron guns?*

From the 3 to the 12 pounder, the charge is equal to the shot's weight, and from the 18 to the 42 pounder $\frac{3}{4}$ of the shot's weight.

E 2　　　80. *What*

**80.** *What quantity of powder is used for proving carronades ?*

From $\frac{1}{4}$ to $\frac{1}{5}$ of the shot's weight.

**81.** *What is the charge of powder for proving brass guns ?*

For heavy and medium guns it is equal to the shot's weight, and for light guns $\frac{1}{2}$ of the shot's weight.

**82.** *What quantity of powder is made use of for proving mortars and how-itzers ?*

As much as will fill the chamber.

**83.** *How is the quantity of powder ascertained that will fill a given chamber ?*

The content of the chamber in inches, is to be divided by 30, and the quotient will be the quantity of powder, in pounds.

84. *What*

84. *What is termed the recoil of a piece of artillery?*

It is the running back of a gun when fired.

85. *What is called the dispart in gunnery?*

It is half the difference between the diameter of the base ring and the diameter of the swell of the muzzle.

86. *How is the dispart found?*

By measuring the two diameters with a pair of calliper compasses.

87. *The angle of dispart being known, how is the length of the dispart ascertained in inches?*

By this proportion, as radius is to the tangent of the given angle, so is the length of the piece (in inches) to the length of the dispart.

88. *The*

88. *The dispart, the semidiameter of of the base ring and the length of a gun being given; how is the distance found, from the piece to the point of intersection, made by the prolongation of the line of metal and that of the axis of the piece?*

By this proportion, as the dispart is to the semidiameter of the base ring, so is the length of the piece to the distance required.

89. *What is meant by tirtiating a gun?*

It is to examine the thickness of metal of the several parts; which is done with a pair of calliper compasses.

90. *What is termed quadrating a gun?*

It is to examine, if a gun is truly placed on its carriage, and wh·⁖   ⸴⸳

wheels are of an equal height; which is done by means of a spirit level.

91. *What is the line of metal?*

It is the visual line forming a tangent with the base ring and the swell of the muzzle.

92. *What is the centre of metal?*

It is a small mark made upon the swell of the muzzle and another upon the base ring of a gun or howitzer, corresponding with the axis of the piece.

93. *How is the centre of metal taken?*

With a spirit level.

94. *What is the range of a piece?*

It is the distance from any gun or mortar, to the point where the projected shot or shell touches the ground.

95. *What*

95. *What is a random shot ?*

When discharged from a piece ele-vated above the horizontal or point blank direction.

96. *What elevation gives the greatest range on a horizontal plane ?*

At an angle of 45 degrees.

97. *What is the point blank of a gun ?*

It is the distance from the piece to the first graze of the shot on a level plane, the axis of the piece being laid hori-zontally.

98. *What is termed ricochet firing ?*

When guns, howitzers or mortars are loaded with small charges, and ele-vated at an angle from 3 to 13 degrees, so as to throw the shot or shell, with several grazes or bounds, either on land or water.

99. *What*

99. *What charge of powder is used for ricochet firing?*

It depends on the requisite elevation of the piece, and the distance of the object, as also on the inclination of the plane.

100. *What is the point blank range of a heavy 24 pounder brass gun?*

473 yards, with a charge $\frac{1}{3}$ of the shot's weight.

101. *What is the point blank range of a light 24 pounder brass gun?*

162 yards, with a charge of $\frac{1}{8}$ of the shot's weight.

102. *What is the point blank range of a 68 pounder carronade?*

450 yards, with a charge of $\frac{1}{12}$ of the shot's weight.

F          103. *What*

103. *What is the charge of powder for service for iron guns ?*

$\frac{1}{3}$ of the shot's weight.

104. *What is the charge of powder, for service, for heavy and medium brass guns ?*

$\frac{1}{4}$ of the shot's weight.

105. *What is the charge for service for light brass guns ?*

$\frac{1}{3}$ of the shot's weight.

106. *In what case is the greatest charge of powder made use of ?*

In the attack and defence of fortified places, which is about $\frac{1}{2}$ the shot's weight.

107. *What are the charges for field artillery ?*

In

In general actions, in the attack and defence of intrenchments, posts, &c, the charges are between $\frac{1}{4}$ and $\frac{1}{6}$ of the shot's weight, according to the calibre and weight of the gun.

108. *What charge is used for service in mortars and howitzers?*

It depends on the distance to which it is required to throw the shell.

109. *What is the greatest range of a 13 inch sea service iron mortar?*

4200 yards with a charge of 20 pounds of powder, at 45 degrees of elevation on a horizontal plane.

110. *What is the greatest range of a 10 inch sea service iron mortar?*

4000 yards with a charge of 10 pounds of powder, at 45 degrees elevation, on a horizontal plane.

F 2                    111. *What*

111.· *What is the greatest range of a 13 inch land service iron mortar ?*

2100 yards with a charge of 6 pounds of powder at 54° elevation.

112. *What is the greatest range of a 10 inch land service iron mortar?*

1911 yards, with a charge of 3 pounds of powder at 45° elevation.

113. *What is the greatest range admitted for firing stones out of a 15 inch stone mortar ?*

250 yards, with a charge of 2¼ pounds of powder.

114. *What is the greatest distance admitted for firing case shot with guns ?*

With a 12 pounder, 800 yards ; with a 9 pounder, 700 yards ; and with a
6 pounder

6 pounder 600 yards; when the case shot contains large bullets; but when composed of smaller sorts; the 12 pounder 700 yards; the 9 pounder 600 yards; and the 6 pounder 500 yards.

115. *At what distance is case shot fired, with an* 8 *inch howitzer?*

At 400 yards; the case containing about 60 iron shot, of an inch and a half in diameter.

116. *How is a piece of ordnance rendered unfit for service?*

There are several methods, but that most commonly used, is to drive a nail into the vent, which is called nailing up or spiking a piece of ordnance.

117. *What is the weight of an iron shot, whose diameter is* 4 *inches?*

9 pounds.

118. *The*

118. *The diameter and weight of a shot being known; how is the weight of any other shot to be found its diameter being given?*

By the following proportion; as the cube of the diameter of 4 inches is to 9 pounds, so is the cube of the diameter given, to the weight; or by taking $\frac{9}{64}$ of the cube of the diameter for the weight.

119. *The weight of a shot being given, what will be its diameter?*

As the weight of a 9 pound shot is to the cube of its diameter, 4 inches; so is the weight of the given shot, to the cube of its diameter, and the cube root of this last number will be the diameter required.

120. *What is the weight of a leaden ball, whose diameter is 4$\frac{1}{4}$ inches?*

17 pounds.

121. *The*

121. *The diameter and weight of a leaden ball being known, how is the weight of any other ball ascertained its diameter being given?*

As the cube of $4\frac{1}{4}$ to 17, or nearly as 9 to 2 so is the cube of the diameter of the leaden ball, to its weight.

122. *The weight of a leaden ball being given, how is its diameter ascertained?*

The product of the weight by 9 being divided by 2, the cube root of the quotient will be the diameter.

123. *How is the weight of an iron shell ascertained?*

By taking $\frac{9}{64}$ of the difference of the cubes of the external and internal diameters for the weight of the shell.

124. *How*

124. *How is the quantity of powder found to fill a shell?*

By dividing the cube of the interior diameter, in inches, by 57·3 for the pounds of powder.

125. *How is the weight of a piece of ordnance ascertained?*

By dividing it into as many sections, perpendicular to its axis, as may be found necessary to calculate its content in inches, from which the content of the bore being deducted, and the difference multiplied by 5·0833 will give the weight in ounces, if brass; and by 4·2968 when iron.

126. *What is the velocity of sound, in one second of time?*

1142 feet.

127. *How*

127. *How is the distance of a gun as-*
*certained, the report of it being*
*heard 6 seconds, after the appear-*
*ance of the flash ?*

The product of 1142 by 6, will be
the distance in feet.

128. *What is the length of a pendu-*
*lum to vibrate seconds ?*

$39\frac{1}{4}$ inches.

129. *How is the length of a pendulum*
*found to vibrate half seconds, or 120*
*times in a minute ?*

As the square of 120 is to the square
of 60, so is $39\frac{1}{4}$ to the length of the
pendulum required.

130. *How is the number of vibrations*
*performed in a minute of time as-*
*certained, the length of a pendulum*
*being given ?*

G                    The

The product of 39½ by the square of 60, is to be divided by the given length, and the square root of that quotient will be the number of vibrations.

131. *How many feet does a heavy body fall from a state of rest, in the first second of time?*

$16\frac{1}{12}$ feet.

132. *The number of seconds a heavy body takes to fall from a state of rest, being given; how is the space descended to be ascertained?*

By multiplying twice the number of seconds minus 1 by $16\frac{1}{12}$, and the product will be the space described, in feet.

133. *How is the time found, a heavy body is falling, from a given height?*

By

By dividing the given height in feet by $16\frac{1}{12}$, and the square root of that quotient will be the time in seconds.

134. *What angle of elevation gives the greatest range on an horizontal plane?*

That of 45 degrees.

135. *In what proportion to each other are the ranges, at angles equally above and below 45 degrees?*

They are equal each to each respectively.

136. *In what proportion will the range of a body be, if projected with an angle of 15 degrees, to that projected with the same force at an angle of 45 degrees?*

As 1 to 2, that is the range with an

G 2                    angle

angle of 15 degrees, will be half that
of 45 degrees.

137. *What is the range of a body equal
to, when projected with an angle of
45 degrees ?*

To the square of the time of its flight,
expressed in seconds, multiplied by $16\frac{1}{12}$
feet.

138. *What will be the horizontal
ranges, of a body being projected
with the same force, but with dif-
ferent angles of elevation ?*

They will be as the sines of angles,
double those of the elevations respec-
tively.

139. *In what proportion to each other,
are the times of flight of the same
body, projected with the same force,
with different angles of elevation ?*

They

They are to each other, as the sines of the angles of elevation.

140. *How is the number of shot or shells contained in a triangular pile to be computed ?*

The number in one of the sides of the base, is multiplied by the same number plus 1, and this product again by the same number plus 2, $\frac{1}{6}$ of this last product will be the number required.

141. *How is the number of shot found, which are contained in a square pile ?*

The number in one of the sides of the base is multiplied by the same number plus 1, this product again by double the same number plus 1, and $\frac{1}{6}$ of this last product will be the number required.

142. *How is the number of shot ascer-*
                                    *tained*

*tained in a rectangular or oblong pile?*

The oblong pile being considered as a frustum of a prism the number in one of the sides of the triangular end, is therefore to be multiplied by the same number plus 1, and half this product again by the sum contained in the three edges, $\frac{1}{3}$ of this last product will be the number required.

143. *How is the number of shot contained in an incomplete pile, to be found?*

By computing what the whole pile would contain if finished, as likewise what the pile taken away contained, and their difference will be the number of shot or shells in the incomplete pile.

144. *What is a battery?*

A battery

A battery consists of a certain number of pieces of ordnance, placed in a row, near one another, and in such a manner as to direct their fire to any required object.

145. *What are field batteries ?*

They are composed of light field pieces, on some convenient spot of ground, in time of an action; their manœuvre is relative to that of the troops, and depends on the position of the enemy. These batteries not being covered by a parapet, are also called, *open batteries.*

146. *What are battering batteries ?*

They are those in which the guns are placed behind a mass of earth called a *parapet* or *breastwork*; of about $7\frac{1}{2}$ feet high, and from 18 to 22 feet thick, having a superior slope of 1 foot.

Openings

Openings are cut in the breastwork, called *embrasures*, for the guns to fire through; the part of the parapet which remains between two embrasures, is called a *merlon.* These batteries are used in sieges to ruin the defences of a place.

147, *What are plein fouet or direct batteries?*

They are those which are placed on the glacis in order to form a breach, and they should be situated within 30 toises of the object to which their fire is directed.

148. *What are ricochet batteries?*

They are of the same construction as battering batteries; their use is to enfilade the faces of the works of a fortification, either with guns, or with howitzers;

itzers; they are also called, *enfilading batteries.*

149. *How is a mortar battery con-
    structed ?*

It consists of a breastwork, without embrasures, of 8 feet high and from 18 to 22 feet thick, having a superior slope whose declivity is 1 foot towards the inside.

150. *What are barbet batteries ?*

They are those in which the platforms are elevated within 2 feet of the crest of the parapet, from which the guns fire over it.

151. *What is a counter battery ?*

It is that which is raised to play on another battery, in order to dismount the guns by a direct fire.

152. *What is a battery en echarpe ?*

H                                    It

It is that which plays obliquely upon the object against which its fire is directed.

153. *How is a battery placed so as to enfilade a work?*

From a point given in the prolongation of the face of a work, proposed to be enfiladed, a perpendicular is erected, upon which the battery is constructed, at the distance of 24 feet from the produced line, in order to clear the thickness of the parapet.

154. *Of what materials are batteries constructed?*

They are made of fascines, saucissons, and earth, and sometimes with gabions or sand bags.

155. *What are fascines?*

They are composed of branches of

trees

trees or brush-wood made up in the form of fagots, of 6 feet long and 8 inches in diameter, tied in two or three places.

156. *What are saucissons ?*

They are fascines from 18 to 20 feet long, and from 10 to 12 inches in diameter ; used in keeping up the earth of a battery.

157. *What are gabions ?*

They are cylindrical baskets, without a bottom, from 3 to 4 feet high, and the same in diameter, to be filled with earth.

158. *What are sand bags?*

They are bags from 10 to 15 inches in diameter, and from 20 to 30 inches long, to contain earth. About 1600 of the second dimensions, are required for the parapet, in the construction of a battery of two pieces.

H 2      159. *What*

159. *What is a platform?*

It is a floor of wood, stone or other materials, on which cannon are placed; its length is from 18 to 20 feet; its breadth, close to the breastwork 8 feet, and behind, from 14 to 15 feet, having a declivity of 8 or 9 inches towards the breastwork, to prevent too great a recoil of the piece.

160. *What are the dimensions of the embrasures, and what distance are they asunder?*

They are from 8 to 9 feet wide without, and from 20 to 24 inches within, their height above the platform which space is called *genouillere,* is from 2 to $2\frac{1}{2}$ feet, according to the nature of the calibre, the bottom or sole of the embrasure has a slope towards the outfide of $1\frac{1}{2}$ foot, their distance asunder is from 18 to 20 feet, from centre to centre.

161. *How*

161. *How many men are required in the construction of a battery in 24 hours ?*

For the first piece 23 men, that is 11 artillery and 12 artificers (sergeants not included), to which 15 men are added for each piece the battery is to contain besides the first, that is, 3 artillery and 12 artificers.

162. *What weight can a man carry ?*

About one hundred wt. and he can draw about 27 pounds in a horizontal direction.

163. *What weight can be carried by a horse or mule ?*

About 2 hundred wt. and he can draw as much as seven men, which is 189 pounds; but when assisted by a wheel carriage, a horse or mule will draw about 3 hundred wt. for a length of time, on a smooth

a smooth plain or level road ; but when in a hilly country one fifth of the weight must be deducted.

164. *What weight can be drawn by*

... ... service of them.

The

The figure of the park of artillery, is that of a parallelogram; except the ground should render another form necessary.

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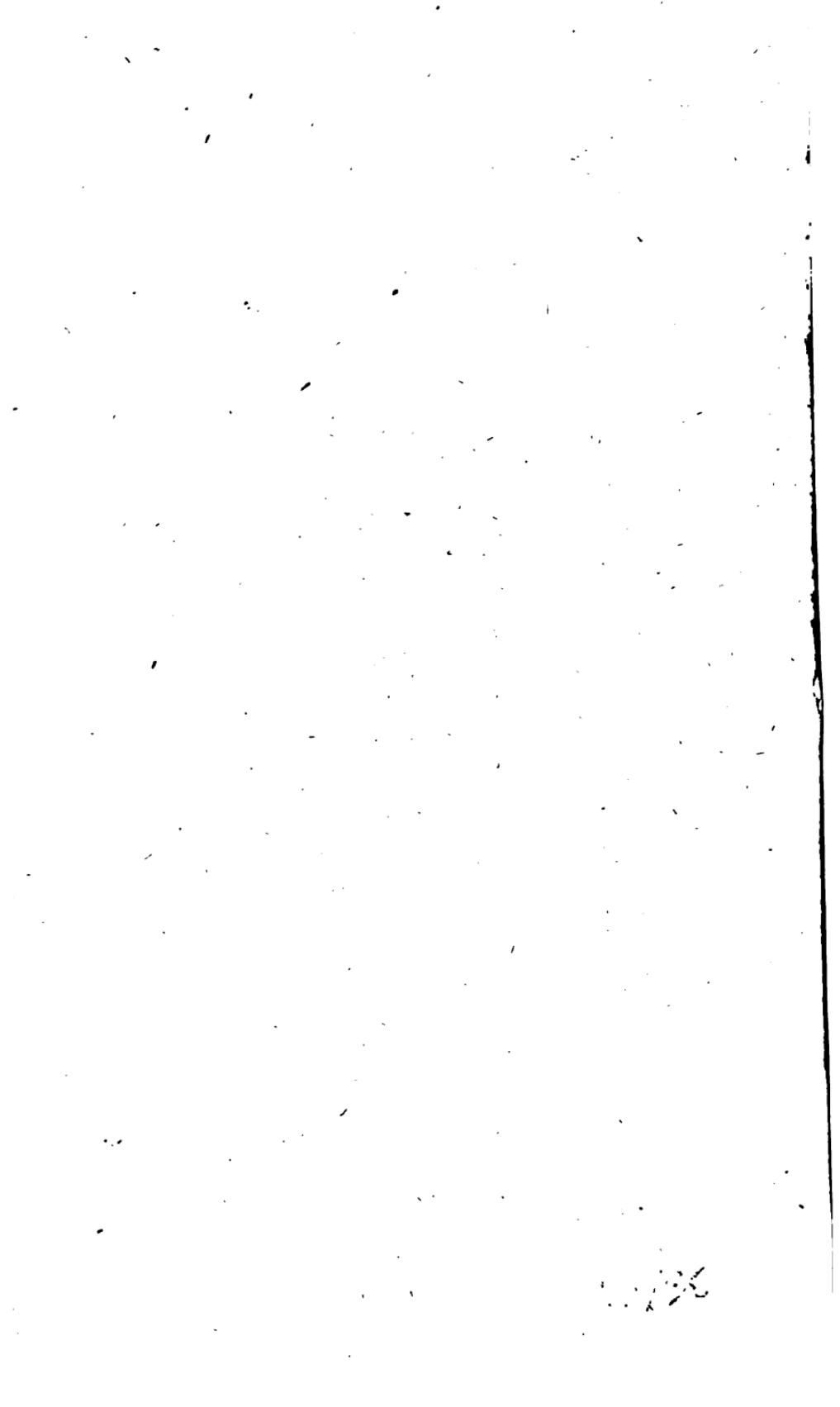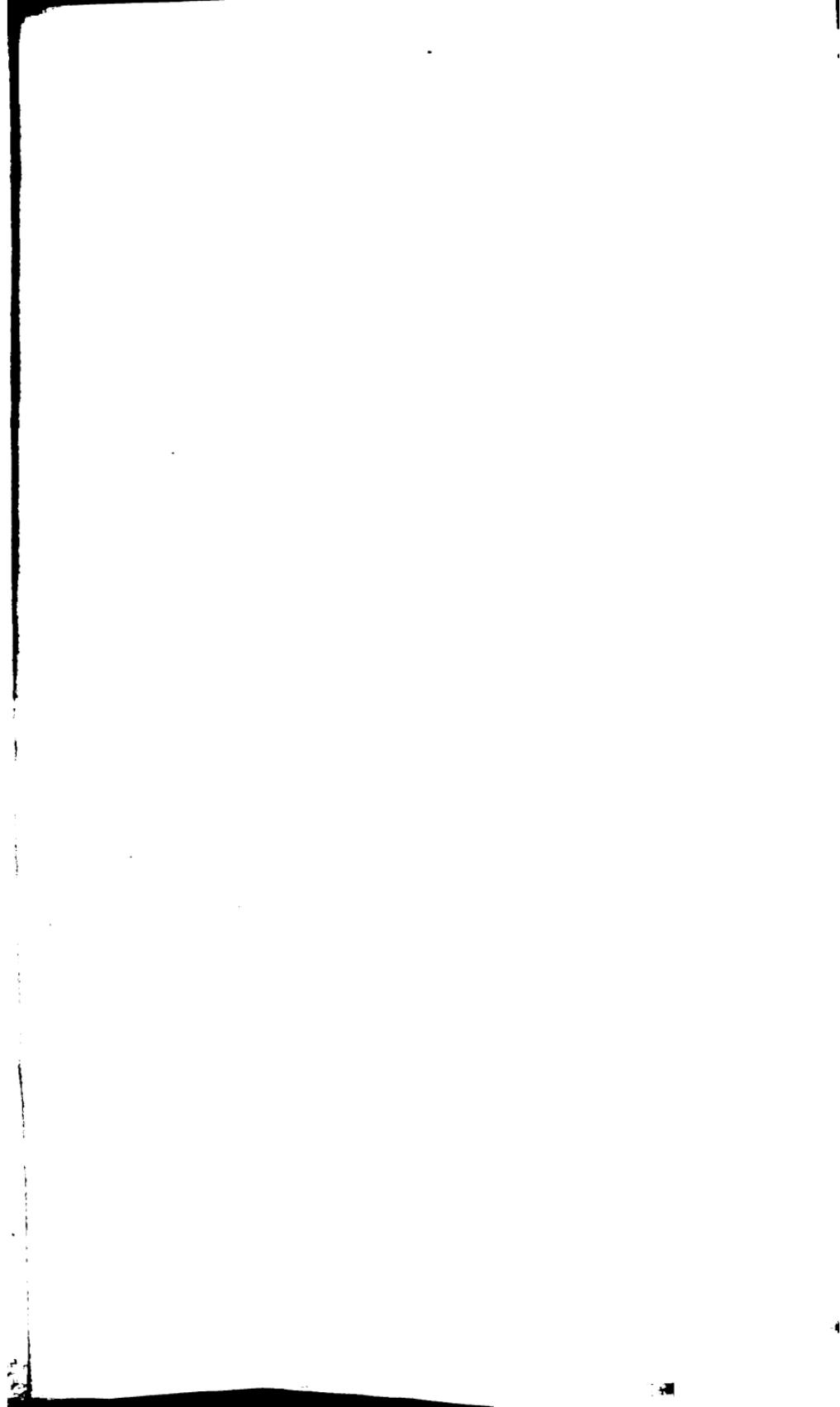
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